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(71)(72) Applicants and Inventors: KUOSMANEN, Petri, Olavi [FI/FI]; Tahkorinne 15 C, FIN-02760 Espoo (FI). VÄÄNÄNEN, Pekka, Tapio [FI/FI]; Kaskilaaksontie 3 C 72, FIN-02360 Espoo (FI).

(74) Agent: OLLIKAINEN, Rauno; Leitzinger Oy, Ruoholahdenkatu 8, FIN-00180 Helsinki (FI).

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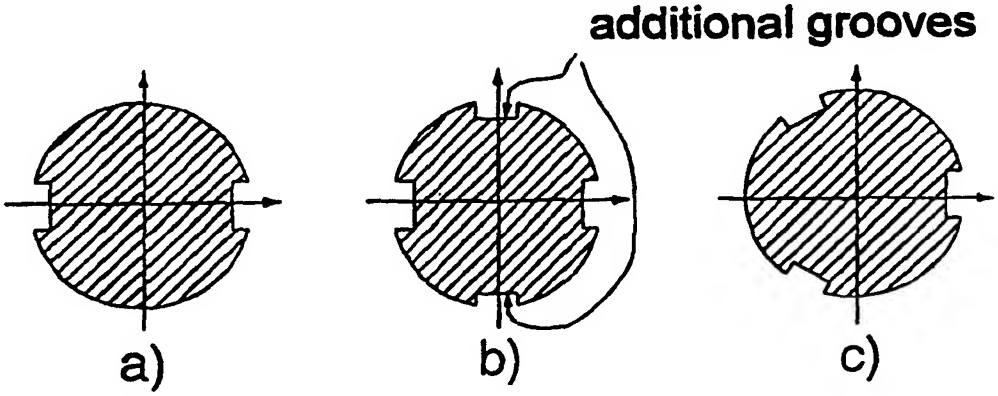
(54) Title: METHOD AND APPARATUS FOR CONTINUOUSLY BALANCING AND REDUCING THE FLEXURAL RIGIDITY OF A FLEXIBLE ROTOR, PARTICULARLY A ROLL OR A CYLINDER




(57) Abstract

The invention relates to a method for reducing the flexural rigidity fluctuation of a roll or a cylinder and for lessening the ellipticity caused by flexural rigidity fluctuation in machining and for diminishing a semi-critical disturbance occurring in operation. The reasons for flexural rigidity fluctuation include grooves, splines as well as structural fluctuations in a roll, such as variation of the coefficient of elasticity or wall thickness of material or the ellipticity of a roll. The roll comprises a load-bearing body and a possible coating element made of a paper fiber, a fabric or a synthetic material. The measured or calculated flexural rigidity fluctuation or imbalance of a roll is compensated for by making new groove(s) or pocket(s) or by changing the size of previously machined grooves or pockets. The grooves or pockets are disposed such that the combined effect thereof diminishes the imbalance or flexural rigidity fluctuation or both in a roll.

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Method and apparatus for continuously balancing and reducing the flexural rigidity of a flexible rotor, particularly a roll or a cylinder.

The present invention relates to a method for reducing the flexural rigidity fluctuation and imbalance of a flexible rotor, such as a roll, by machining material off the outer surface or inner surface of the roll by means of axially extending grooves or pockets, as well as to an apparatus for internal machining according to the method.

It is prior known that the flexural rigidity fluctuation of a roll is caused by axially extending grooves, material variations, wall thickness variations in a tubular-bodied roll or ellipticity of a roll.

It is prior known to reduce the imbalance and dynamic deflection of a roll by the addition of material: by securing weights or mass to the ends or in the middle of a roll, by injecting material to the light side of the inner periphery of a tubular roll.

It is prior known to reduce the imbalance and dynamic deflection of a roll by the removal of material: by drilling holes in the jacket of a roll, by internally turning a roll to a constant wall thickness or by aligning a roll in the turning of an outer surface according to the centre axis of a bore.

The rolls may be coated. The coated roll consists of an axle and a coating element which can be made of a paper or fabric fiber or a synthetic material or a combination thereof. The coated rolls are used in paper industry for example as calender glazing rolls and as various guide rolls. It is prior known to secure the positive attachment of a coating by providing the fiber-coated calender glazing rolls with

one or two grooves (as an adhesive injection duct) or with a spline.

As for the alignment of rolls, it has been found out e.g. by the Applicants that the rolls are generally elliptical even after a successful alignment. The ellipticity is at its peak in the mid-section of a roll, reducing towards the ends of a roll in proportion to the sag of a roll. The calender glazing rolls, which are provided with diametrally located, axially extending adhesive injection grooves, have typically a measurable, distinct, elliptical circularity profile, having a size of 15-30 μm and an angle of 45° relative to the grooves included in the axle. The grooves cause fluctuation in flexural rigidity, which appears in the motion of the rotational centre axis of a roll in the form of two rotations as the roll does a single rotation. In machining, this results in an elliptical circularity profile as the turning tool remains stationary. In a calender, the elliptical rolls subject the calender to vibration and periodical nip pressure fluctuation which is reproduced on a paper to be glazed. The flexural rigidity fluctuation is also known to be a significant source of known semi-critical vibration, which appears when the roll has a rotating frequency which is half of the specific frequency of the transverse vibration of the roll.

An object of the invention is to provide a method capable of extending the service life of rolls and bearings included therein, increasing the running properties and running speed of a paper making machine or a calender, as well as improving the grade of paper by reducing the flexural rigidity fluctuation and imbalance of a roll. The measured flexural rigidity fluctuation or imbalance is compensated for by making grooves or pockets or by adjusting the size of previously machined grooves or pockets. According to a method of the invention, the grooves or pockets required in a roll due to the functional requirements of the roll are disposed at

least in such a manner that, in any case, the grooves or pockets as such do not cause more flexural rigidity fluctuation or imbalance in the roll.

This object of the invention is achieved on the basis of the characterizing features set forth in the annexed claims. A few exemplary embodiments of the invention will now be described in more detail with reference made to the accompanying drawings, in which

fig. 1 shows schematically in cross-section a calender fiber roll, including a) a current generally used system, b) an improved system of the invention applicable to existing rolls, c) a system applicable to new fiber rolls.

Fig. 2 shows schematically a cross-section for a coated roll after forming the outer surface of a roll body (1) with a compensating groove according to a first embodiment of the invention, whereafter the body is coated with a coating (2) and machined to be circular.

Fig. 3 shows an apparatus according to a second embodiment of the invention for the internal machining of a tubular roll (1), the apparatus comprising a milling head (3) adjustable in radial and circumferential direction of the roll jacket, a body (4), bracing legs (5), a pulse sensor (6), a cutting fluid nozzle (7) and a control unit (8).

Example of embodiment 1. Removal of material off the outer periphery of a roll body.

A method for achieving the object of the invention can be applied to improving the operation of calender glazing rolls. The most convenient way is to provide the presently

used rolls, including two adhesive injection grooves, with two more grooves (fig. 1) for reducing the flexural rigidity fluctuation caused by the grooves. Three grooves are capable of achieving a very insignificant fluctuation of flexural rigidity compared to what is caused by two diameterally located grooves of the same size. The use of four or more grooves provides no further essential advantage. The increased number of grooves also provides a more even passage of adhesive in between the coating and the body.

A method of the invention can also be used for balancing a roll by machining unequally sized grooves on the opposite sides of the roll. This does not essentially change the flexural rigidity fluctuation of a roll compared to the condition in which the grooves have equal cross-sectional areas.

Example of embodiment 2. Removal of material off the inside of a tubular roll.

A method of the invention is not restricted to just removing material externally of the axle of a roll but, instead, a method of the invention can be used for balancing and eliminating the flexural rigidity fluctuation from tubular-bodied rolls by means of internal machining (fig. 3). The machining is effected on the basis of measurements to find out the balance and flexural rigidity fluctuation of a roll to be machined. The measurements can be based for example on measuring the motion of the centre of the mid-section of a roll or on measuring the circularity profile or diametral fluctuation after the machining operation.

This procedure may replace internal turning, which is an expensive and tedious process. A benefit gained by internal turning has been the reduction of a wall thickness and thereby an improved balance and lesser fluctuation of flexural rigidity and thus also a lesser semi-critical distur-

bance. A smooth inner tube surface resulting from internal turning is not usually exploited at all.

The removal of material off the inner surface of a tubular roll can be effected e.g. with an apparatus as shown in fig. 3.

It is obvious that the invention is not limited to the above embodiments. The invention can be further supplied, as shown for example in fig. 2, to improving the operation of tubular-bodied coated rolls by machining or milling material off the outer periphery of a roll body at suitable spots. The strict circularity and cylindricity requirements set on a roll are fulfilled after the coating and machine finishing.

The axially extending grooves can be used for compensating flexural rigidity fluctuation provided that the grooves are dimensioned such that the flexural rigidity fluctuation caused thereby is substantially equal to but oppositely directed to the flexural rigidity fluctuation of a roll.

Claims

1. A method for reducing the flexural rigidity fluctuation of a roll or a cylinder and for lessening the ellipticity caused by flexural rigidity fluctuation in machining and for diminishing a semi-critical disturbance occurring in operation, the reasons for said flexural rigidity fluctuation including grooves, splines as well as structural fluctuations in a roll, such as variation of the coefficient of elasticity or wall thickness of material or the ellipticity of a roll, said roll comprising a load-bearing body and a possible coating element, said coating element being made of a paper fiber, a fabric or a synthetic material or a combination thereof and its adherence being secured or movement relative to the axle being prevented in various ways, c h a r a c t e r i z e d in that the measured or calculated flexural rigidity fluctuation or imbalance of a roll is substantially compensated for by making new groove(s) or pocket(s) or by changing the size of previously machined grooves or pockets, said grooves or pockets being disposed such that the combined effect thereof diminishes or at least does not increase the imbalance or flexural rigidity fluctuation or both in a roll.

2. A method as set forth in claim 1, c h a r a c t e r i z e d in that the roll body includes after the machining at least three grooves or pockets parallel to the body.

3. A method as set forth in claim 1 or 2, c h a r a c t e r i z e d in that a roll body, especially a calender roll body to be upgraded and provided with two diametrally located grooves, is machined to include therein two additional grooves parallel to the body such that the grooves are positioned in circumferential direction at intervals of exactly or approximately 90°.

4. A method as set forth in claim 1 or 2, c h a r a c -

t e r i z e d in that the flexural rigidity fluctuation caused by grooves is reduced by providing the roll body with three axially extending grooves positioned in circumferential direction at intervals of exactly or approximately 120°.

5. A method as set forth in claim 1, c h a r a c t e r i z e d in that a calender roll body is provided with at least three axially extending keyways and splines for securing the adherence of a weighting element.

6. A method as set forth in claims 1-3, c h a r a c t e r i z e d in that a paste to be injected between the calender roll body and the weighting element is injected along at least three axially extending grooves.

7. A method as set forth in claim 1, c h a r a c t e r i z e d in that the removal of material is effected at least at one spot off the outer surface of a tubular roll body to be coated.

8. A method as set forth in claim 1, c h a r a c t e r i z e d in that the removal of material is effected at least at one spot off the inner surface of a tubular roll body.

9. A method as set forth in claims 1 and 8, c h a r a c t e r i z e d in that the removal of material is effected at least at one spot from the inside of a tubular roll by means of an apparatus to be guided in through the end of the tube.

10. A method as set forth in claims 8-9, c h a r a c t e r i z e d in that the removal of material is effected at least at one spot from the inside of a tubular roll by means of an apparatus of a miller type to be guided in through the end of the tube.

11. An apparatus for balancing or reducing the flexural rigidity fluctuation of a tubular-bodied element, such as a roll or a cylinder, by the application of a method as set forth in any of claims 9-10, said apparatus comprising at least one milling head adjustable relative to the radius and the angle of rotation of the roll, a body, bracing soles, a cutting fluid nozzle and a control unit, c h a r a c t e r i z e d in that the apparatus enables the machining of grooves or pockets of a desired depth at desired locations over the inner periphery of a tubular roll.

12. An apparatus as set forth in claim 11, c h a r a c t e r i z e d in that it includes two milling heads located on the opposite sides.

13. An apparatus as set forth in claims 11 and 12, c h a r a c t e r i z e d in that the milling heads can be controlled individually.

14. An apparatus as set forth in claims 11-13, c h a r a c t e r i z e d in that the apparatus need not be removed from inside a roll for the duration of measuring the flexural rigidity fluctuation or imbalance or dynamic deflection.

15. An apparatus as set forth in claims 11-14, c h a r a c t e r i z e d in that the apparatus braces itself against the wall of a roll during the course of machining.

16. A method and apparatus as set forth in claims 11-15, c h a r a c t e r i z e d in that the apparatus is provided with bracing legs adjusting according to the inner diameter of a tube.

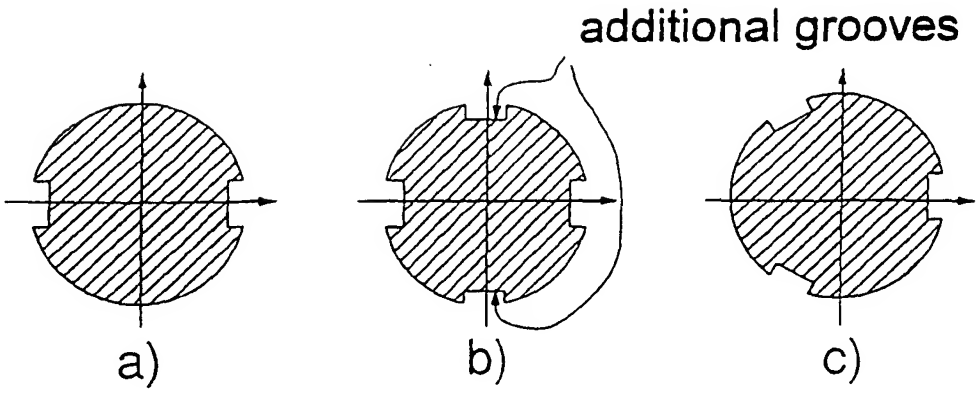


Fig. 1

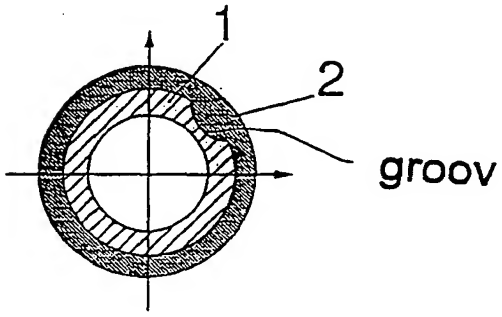


Fig. 2

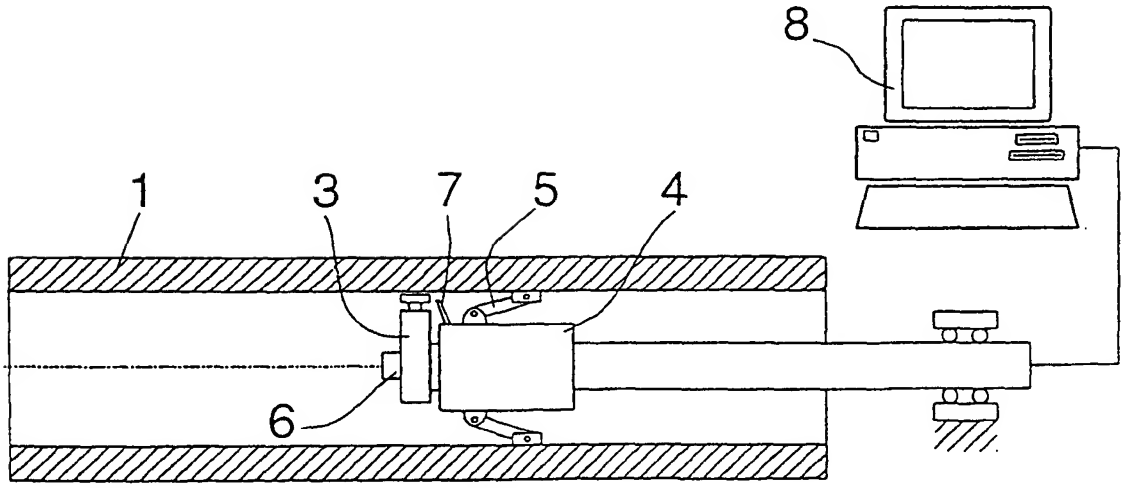


Fig. 3

# INTERNATIONAL SEARCH REPORT

International application No.
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## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F16F 15/32, G01M 1/34
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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